Extended weather and intraseasonal oscillations in the SCS during winter and summer monsoon 2017-2018

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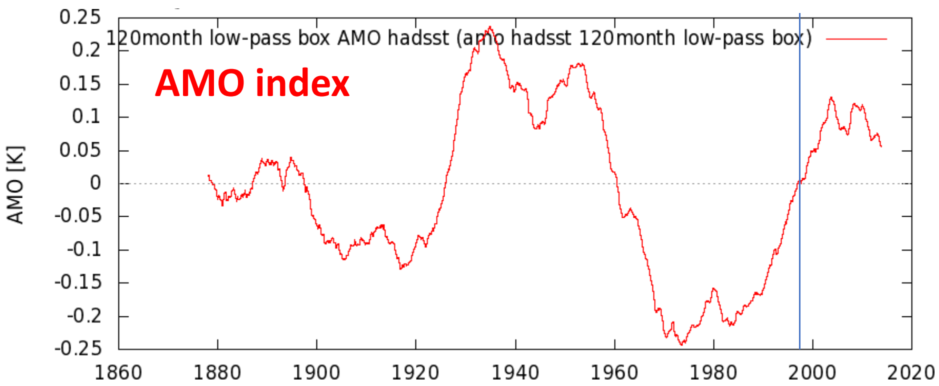
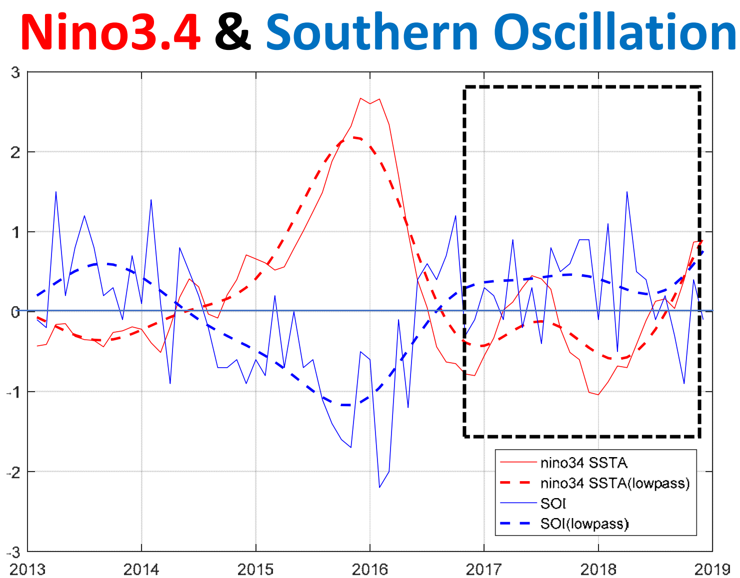
I. **Climate background** of the SCSTIMX 2017-2018
II. The Influences of the MJO & ER on the SCS monsoon onset in June 2018
III. The Influences of Scale-Interactions Involving the MJO (KWs) on Rainfall Variability over SCS and MC in December 2016 (2017)

4th International Workshop of the Years of the Maritime Continent, **Feb 26-28, 2019,** Institute of Environmental Science and Meteorology (IESM), University of the Philippines, Manila

I. Climate background of the SCS Two-Island Monsoon eXperiment (SCSTIMX) 2017-2018

Climate background of the SCS Two-Island Monsoon eXperiment (SCSTIMX) 2017-2018





Global warming hiatus since 2000

- –IPO
- +AMO
- Hemispheric asymmetric SST distribution
- Frequent CP type El Nino
- Strong extratropical influence

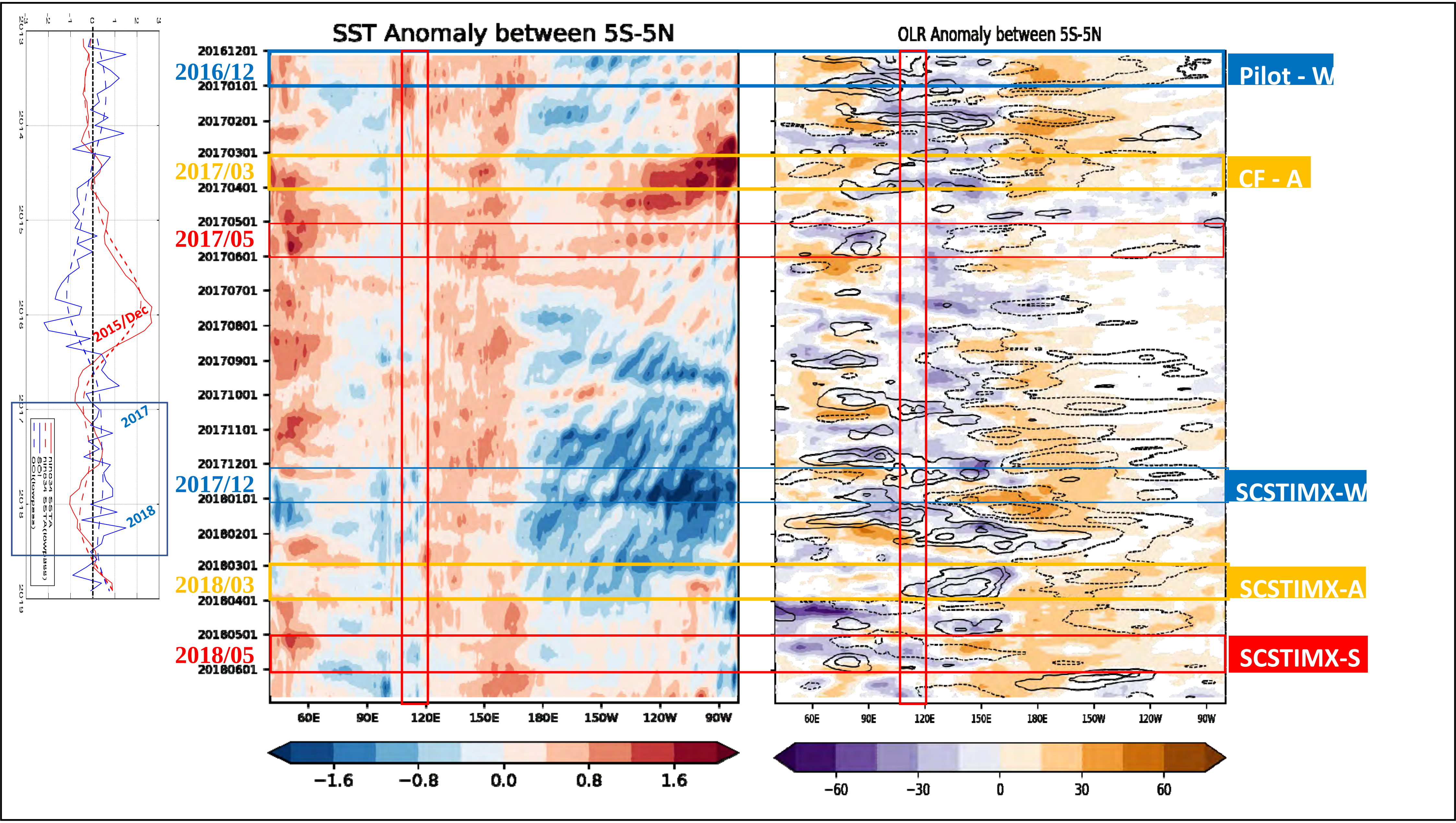
2014-2018 ENSO event

- Super El Nino-weak La Nina
- A prolonged ENSO evolution

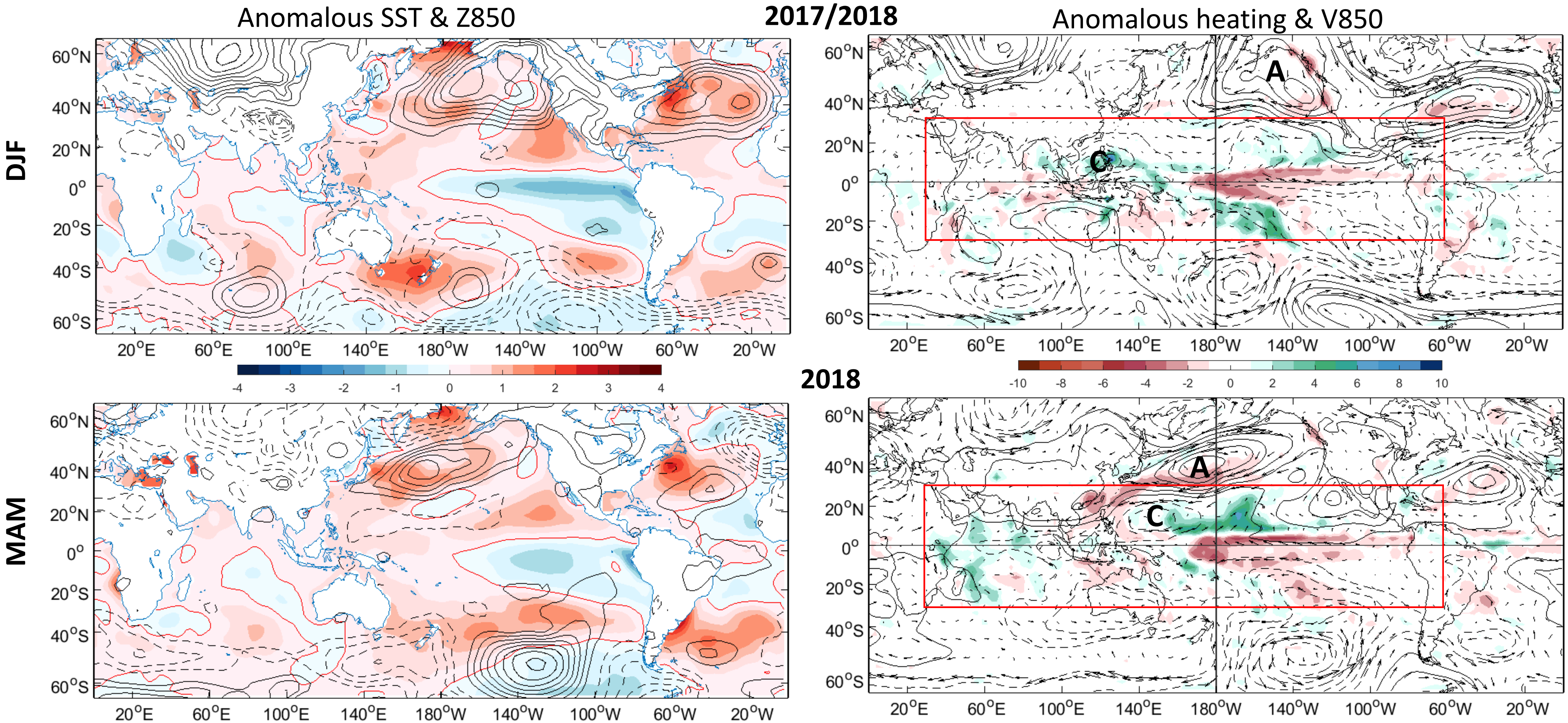
La Nina in DJF (yr0), weak El Nino in DJF (yr1), IOD in SON (yr1), primary El Nino (yr2), followed by a fast decay to La Nina (yr3)

2017-2018

- Weak La Nina phase
- Late SCS monsoon onset, 2018

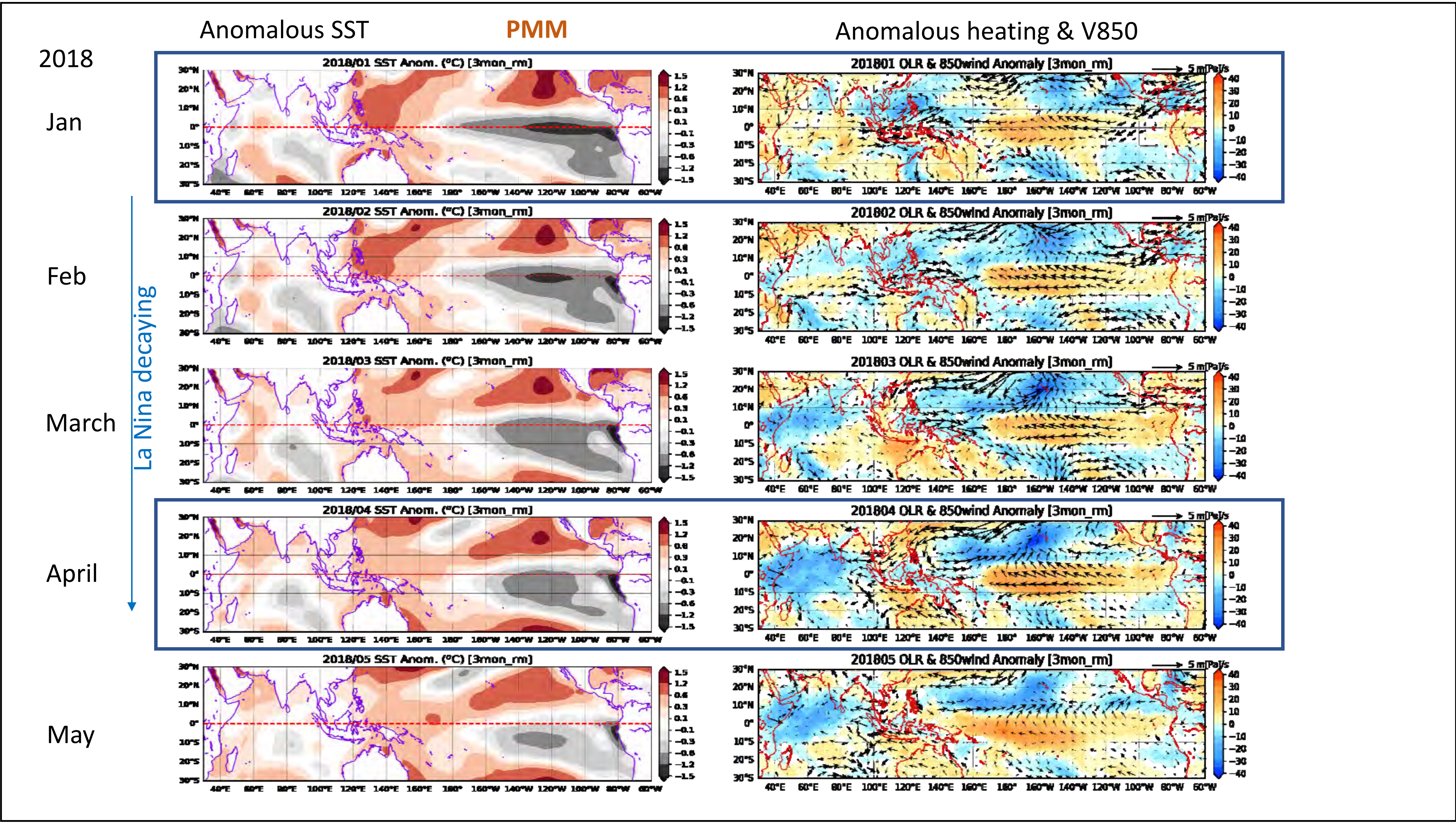


SST Anomaly between 5S-5N
OLR Anomaly between 5S-5N
2016/12
2017/03
2017/05
2017/12
2018/03
2018/05
Pilot - W
CF - A
SCSTIMX-W
SCSTIMX-A
SCSTIMX-S
2015/Dec
2017
2018
20161201
20170101
20170201
20170301
20170401
20170501
20170601
20170701
20170801
20170901
20171001
20171101
20171201
20180101
20180201
20180301
20180401
20180501
20180601
60E
90E
120E
150E
180E
150W
120W
90W
−1.6
−0.8
0.0
0.8
1.6
-60
-30
0
30
60

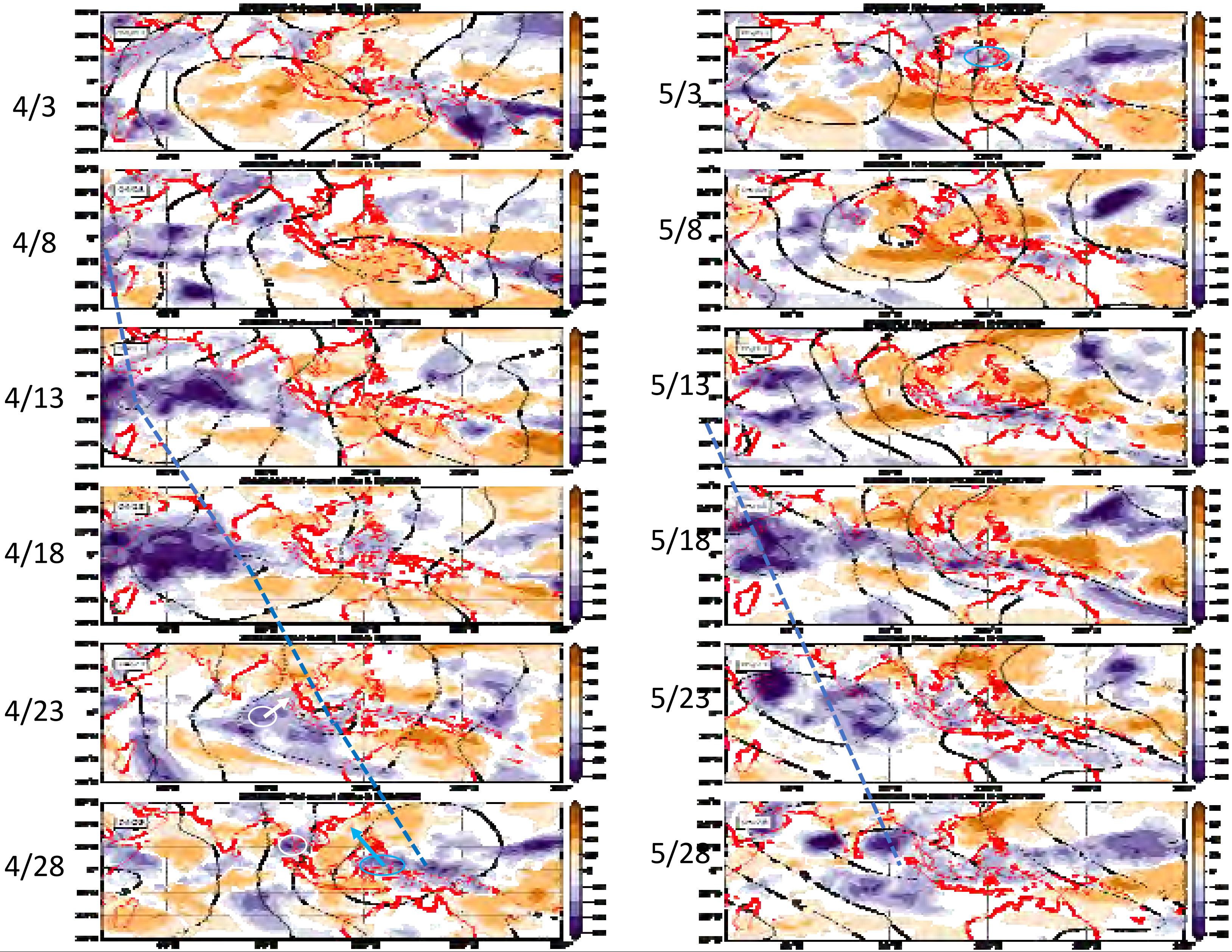


DJF: La Nina forcing→ weakened Aleutian low, weaker westerly jet, warm SSTA in North Pacific (PMM)

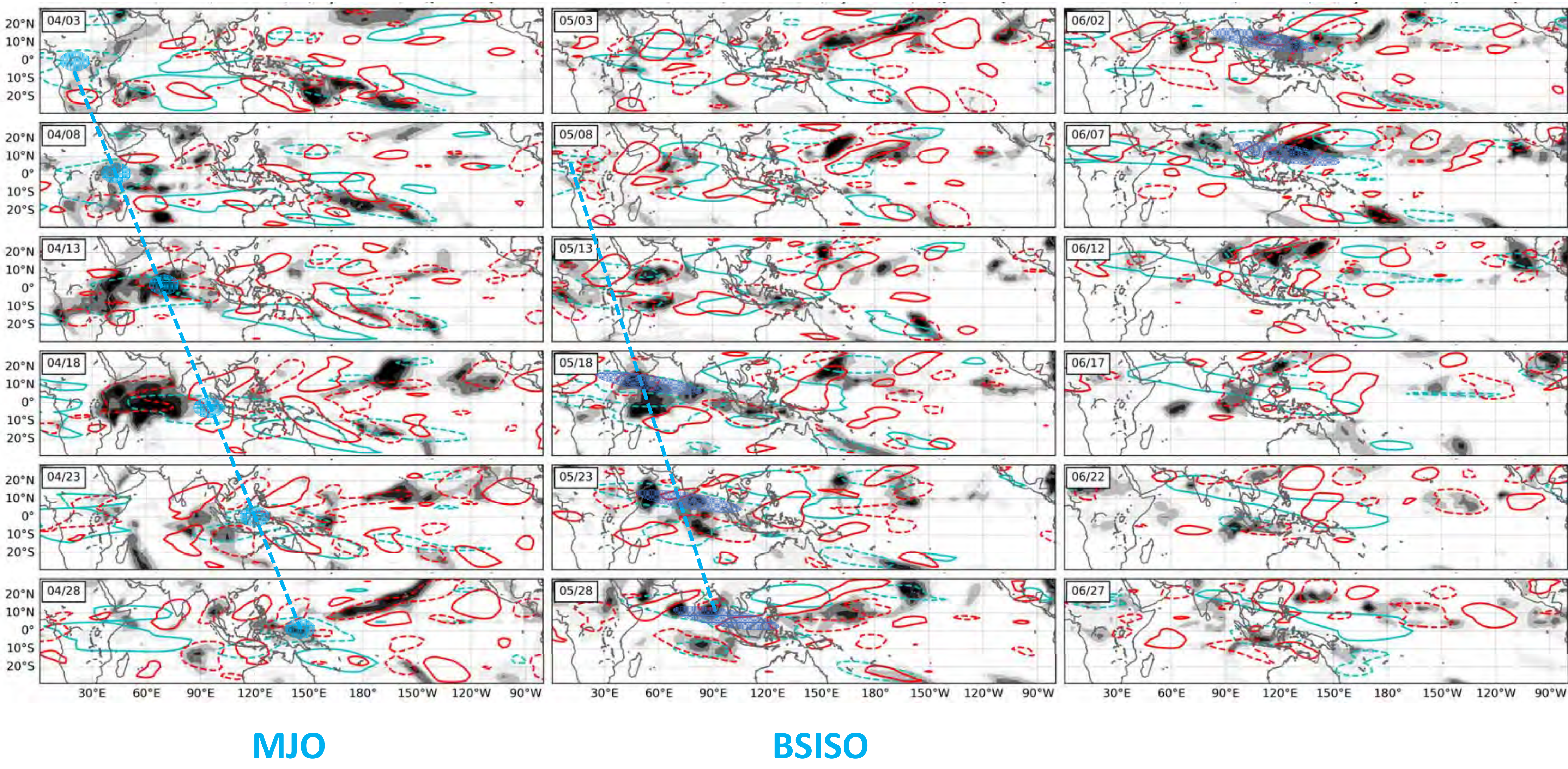
MAM: PMM persisted and move southwestward (WES feedback)


Anomalous SST
PMM
Anomalous heating & V850
2018
Jan
Feb
March
April
May
La Nina decaying
2018/01 SST Anom. (°C) [3mon_rm]
201801 OLR & 850wind Anomaly [3mon_rm]
2018/02 SST Anom. (°C) [3mon_rm]
201802 OLR & 850wind Anomaly [3mon_rm]
2018/03 SST Anom. (°C) [3mon_rm]
201803 OLR & 850wind Anomaly [3mon_rm]
2018/04 SST Anom. (°C) [3mon_rm]
201804 OLR & 850wind Anomaly [3mon_rm]
2018/05 SST Anom. (°C) [3mon_rm]
201805 OLR & 850wind Anomaly [3mon_rm]

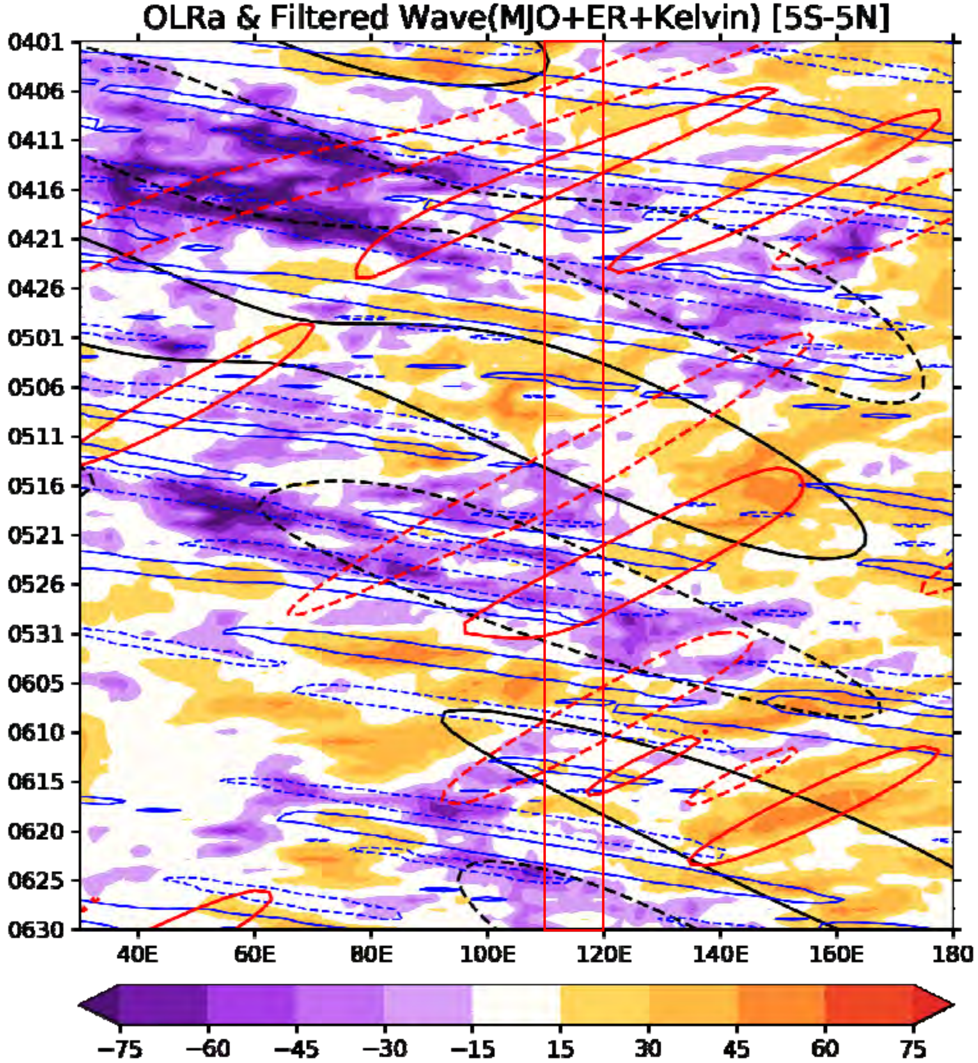
II. The Influences of the ISO and ER on the SCS monsoon onset in June 2018



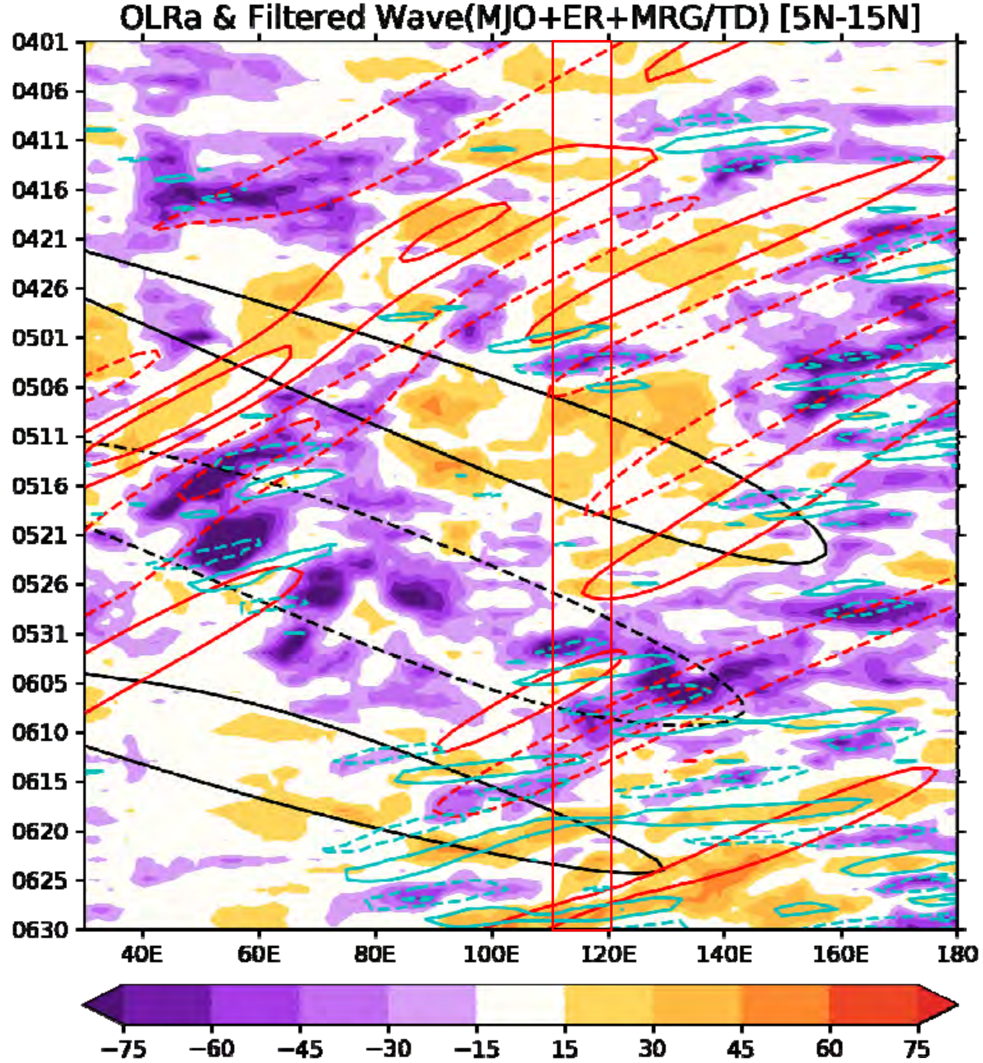
1. Convective system moved eastward slower than MJO during 4/8~4/18
2. Detour the MC during the pentad of 4/23
3. Short-period convective signal during 5/3



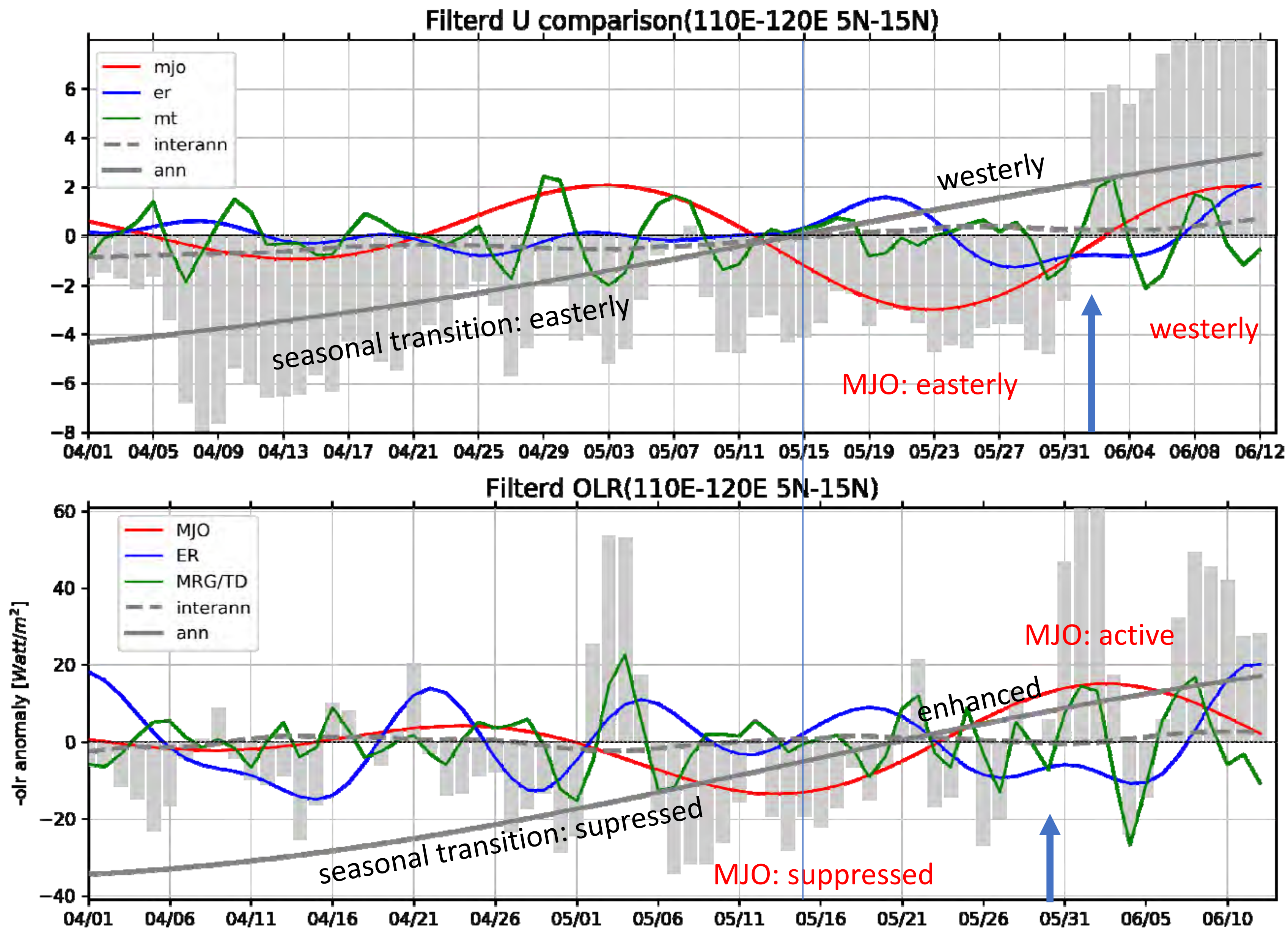
04/03
04/08
04/13
04/18
04/23
04/28
05/03
05/08
05/13
05/18
05/23
05/28
06/02
06/07
06/12
06/17
06/22
06/27
20°N
10°N
0°
10°S
20°S
30°E
60°E
90°E
120°E
150°E
180°
150°W
120°W
90°W
MJO
BSISO



OLRa & Filtered Wave(MJO+ER+Kelvin) [5S-5N]
0401
0406
0411
0416
0421
0426
0501
0506
0511
0516
0521
0526
0531
0605
0610
0615
0620
0625
0630
40E
60E
80E
100E
120E
140E
160E
180
−75
−60
−45
−30
−15
15
30
45
60
75



OLRa & Filtered Wave(MJO+ER+MRG/TD) [5N-15N]
0401
0406
0411
0416
0421
0426
0501
0506
0511
0516
0521
0526
0531
0605
0610
0615
0620
0625
0630
40E
60E
80E
100E
120E
140E
160E
180
−75
−60
−45
−30
−15
15
30
45
60
75



Filterd U comparison(110E-120E 5N-15N)
mjo
er
mt
interann
ann
westerly
seasonal transition: easterly
MJO: easterly
westerly
Filterd OLR(110E-120E 5N-15N)
MJO
ER
MRG/TD
interann
ann
-olr anomaly [Watt/m2]
MJO: active
enhanced
seasonal transition: supressed
MJO: suppressed

I.II Summary

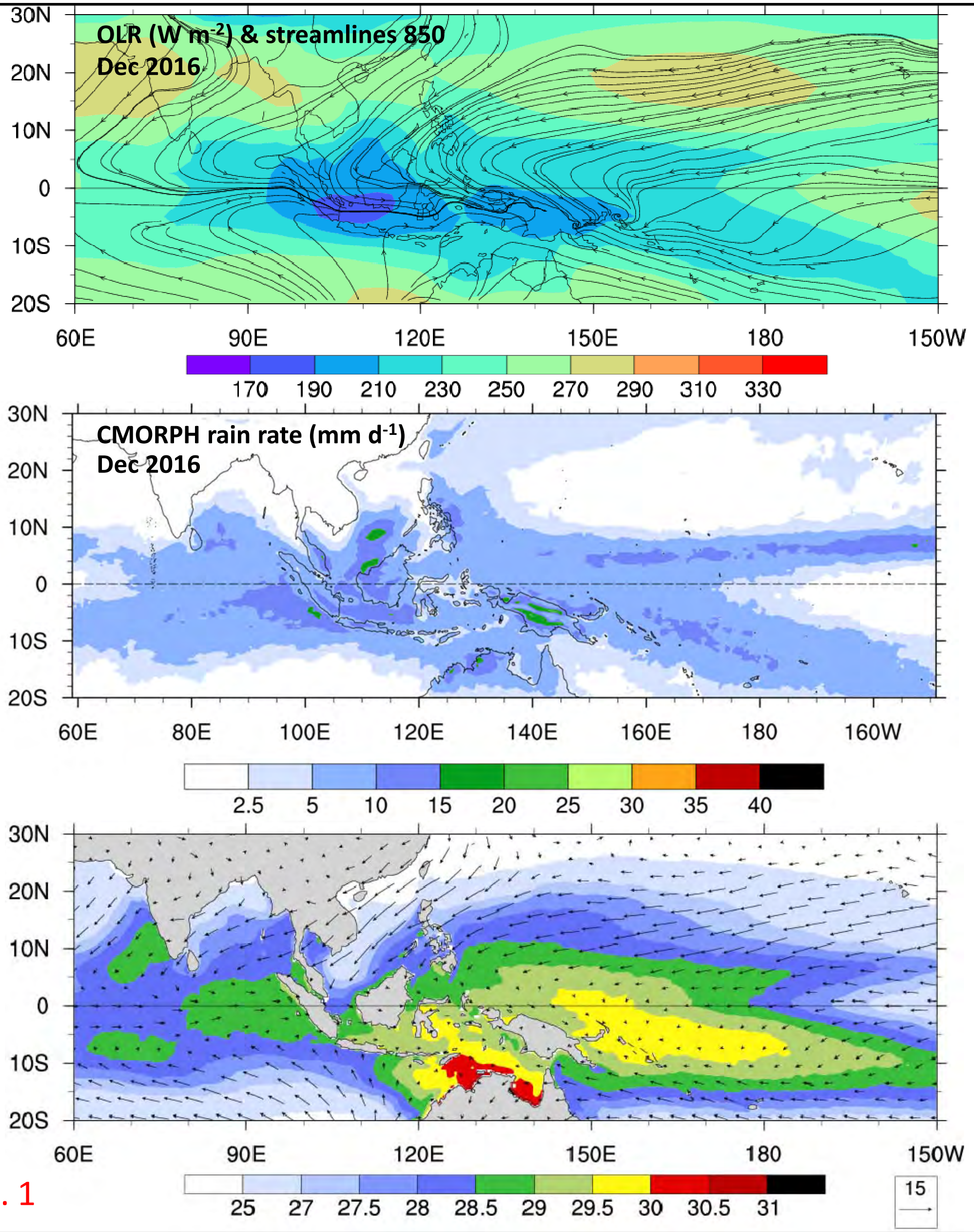
- A Pacific meridional mode (PMM) is evident in the winter-spring 2018, along with an anomalous cyclone (AC) over SCS (DJF) and PS (MAM) during the decaying La Nina phase following the prolonged 2015/16 ENSO
- The AC and PMM are maintained by equatorial heating and extratropical WES feedback in boreal winter monsoon flow
- The AC brought cold-dry northeasterly to SE China coast and SCS in MAM, ISO heating in April and May over IO results in easterly over eastern IO → an anticyclonic circulation (AAC) extending from SCS to IO
- The anomalous AAC, ISO and ER caused a late SCS monsoon onset in June 2018

Q1: PMM and sub-tropical AAC (or AC) over the NW & SCS accompanied with El Nino (La Nina) add to ENSO diversity. Do they also exist in non-ENSO years?

Q2: Maintenance of persistent AAC and AC in NE vs SW monsoon flow remains to be further explored other than the feedbacks via WES, IO heating

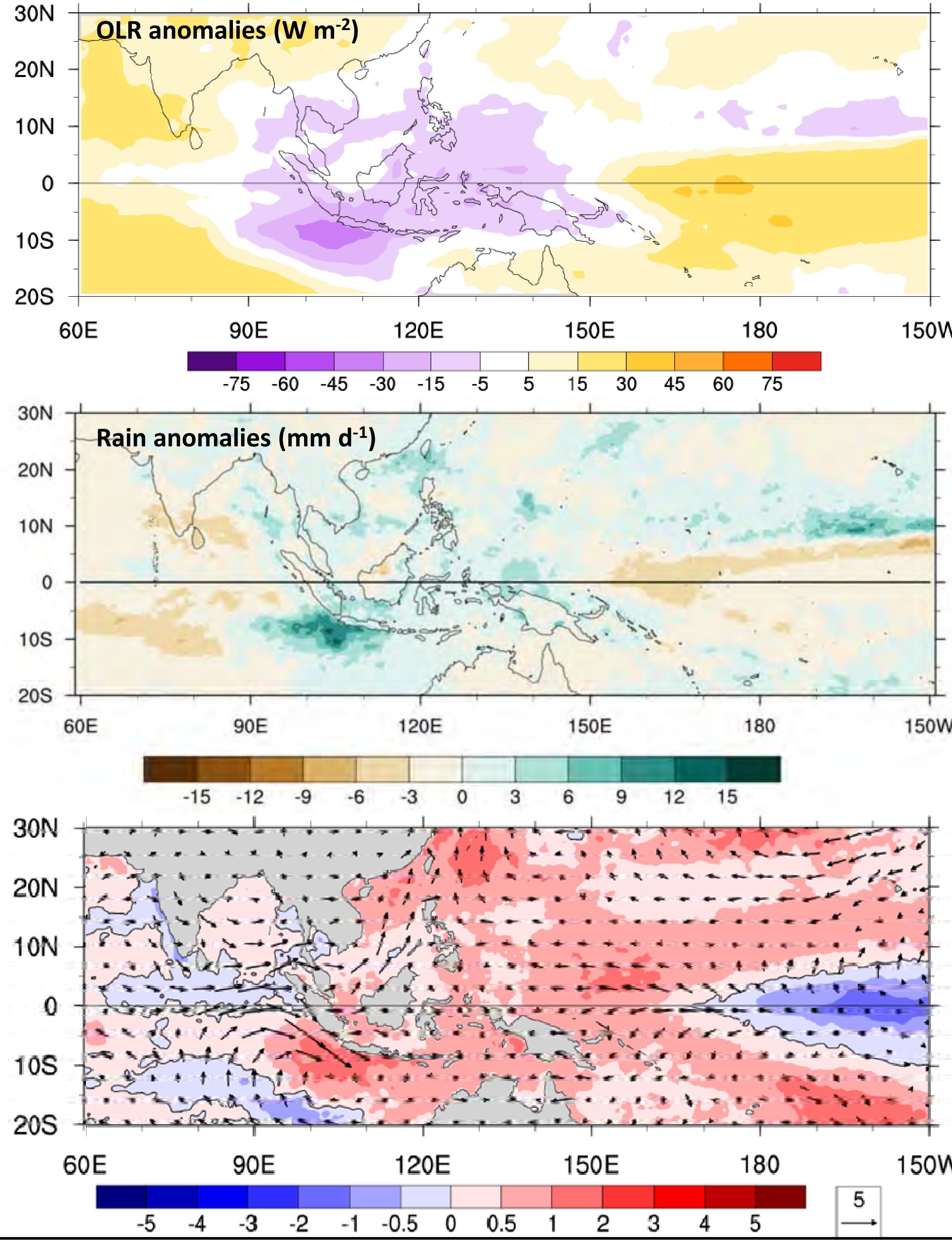
III. The Influences of Scale-Interactions Involving the MJO (KWs) on Rainfall Variability over SCS and MC in December 2016 (2017)

Chen et al. 2019 J. Climate (in review)



OLR (W m-2) & streamlines 850
Dec 2016
30N
20N
10N
0
10S
20S
60E
90E
120E
150E
180
150W
170 190 210 230 250 270 290 310 330
CMORPH rain rate (mm d-1)
Dec 2016
60E
80E
100E
120E
140E
160E
180
160W
2.5 5 10 15 20 25 30 35 40
25 27 27.5 28 28.5 29 29.5 30 30.5 31
15

Fig. 1



OLR anomalies (W m-2)
30N
20N
10N
0
10S
20S
60E
90E
120E
150E
180
150W
-75 -60 -45 -30 -15 -5 5 15 30 45 60 75
Rain anomalies (mm d-1)
-15 -12 -9 -6 -3 0 3 6 9 12 15
-5 -4 -3 -2 -1 -0.5 0 0.5 1 2 3 4 5
5

Fig. 2

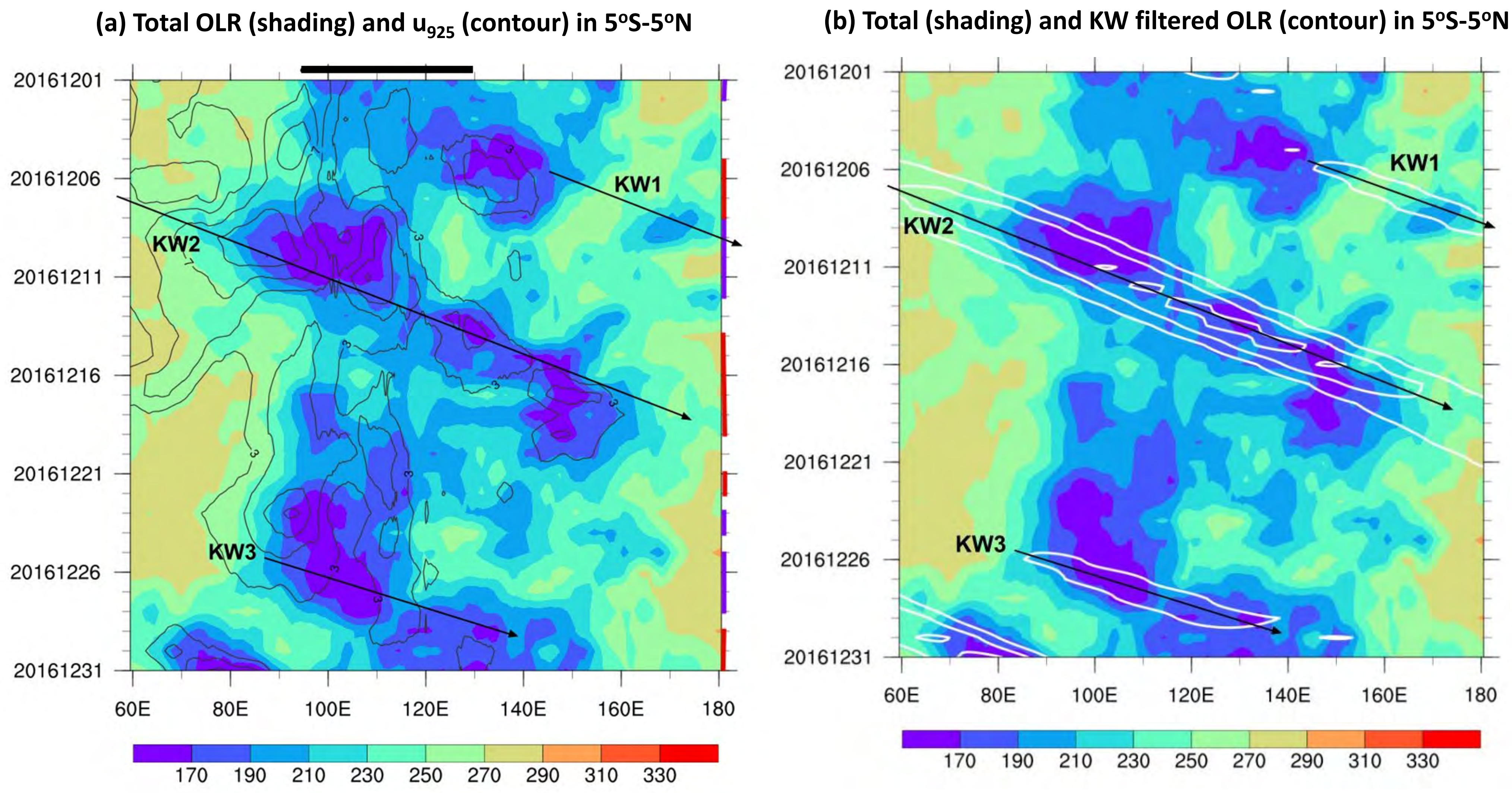

(a) Total OLR (shading) and u925 (contour) in 5oS-5oN
(b) Total (shading) and KW filtered OLR (contour) in 5oS-5oN
KW1
KW2
KW3
20161201
20161206
20161211
20161216
20161221
20161226
20161231
60E
80E
100E
120E
140E
160E
180
170
190
210
230
250
270
290
310
330

Fig. 3

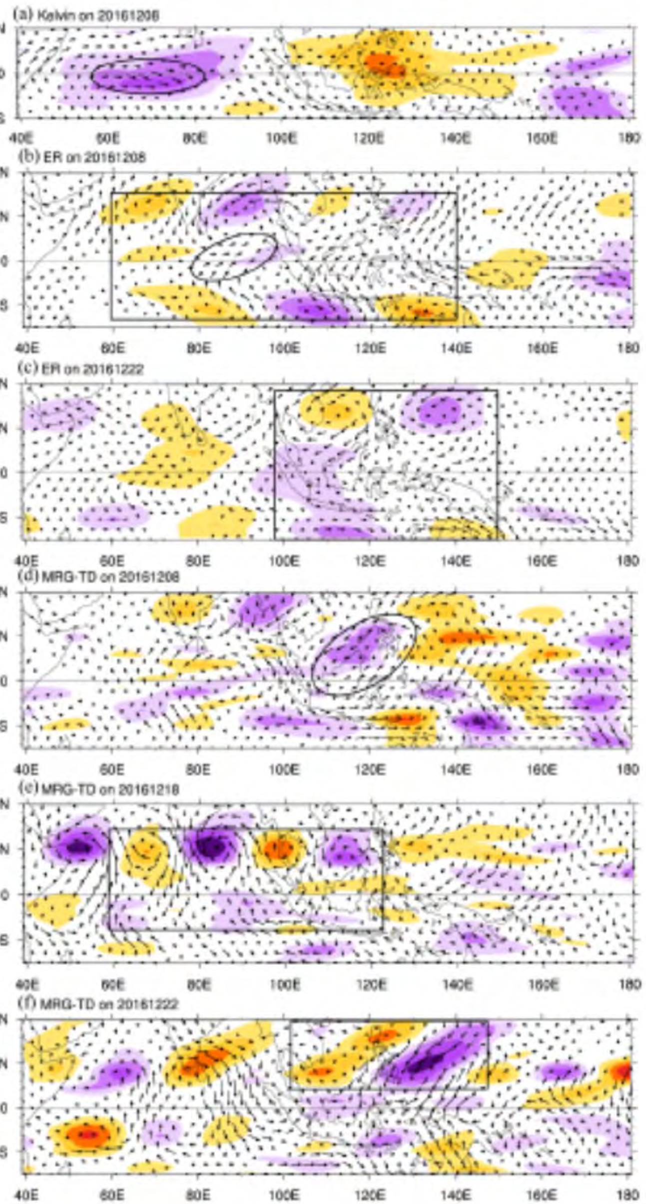
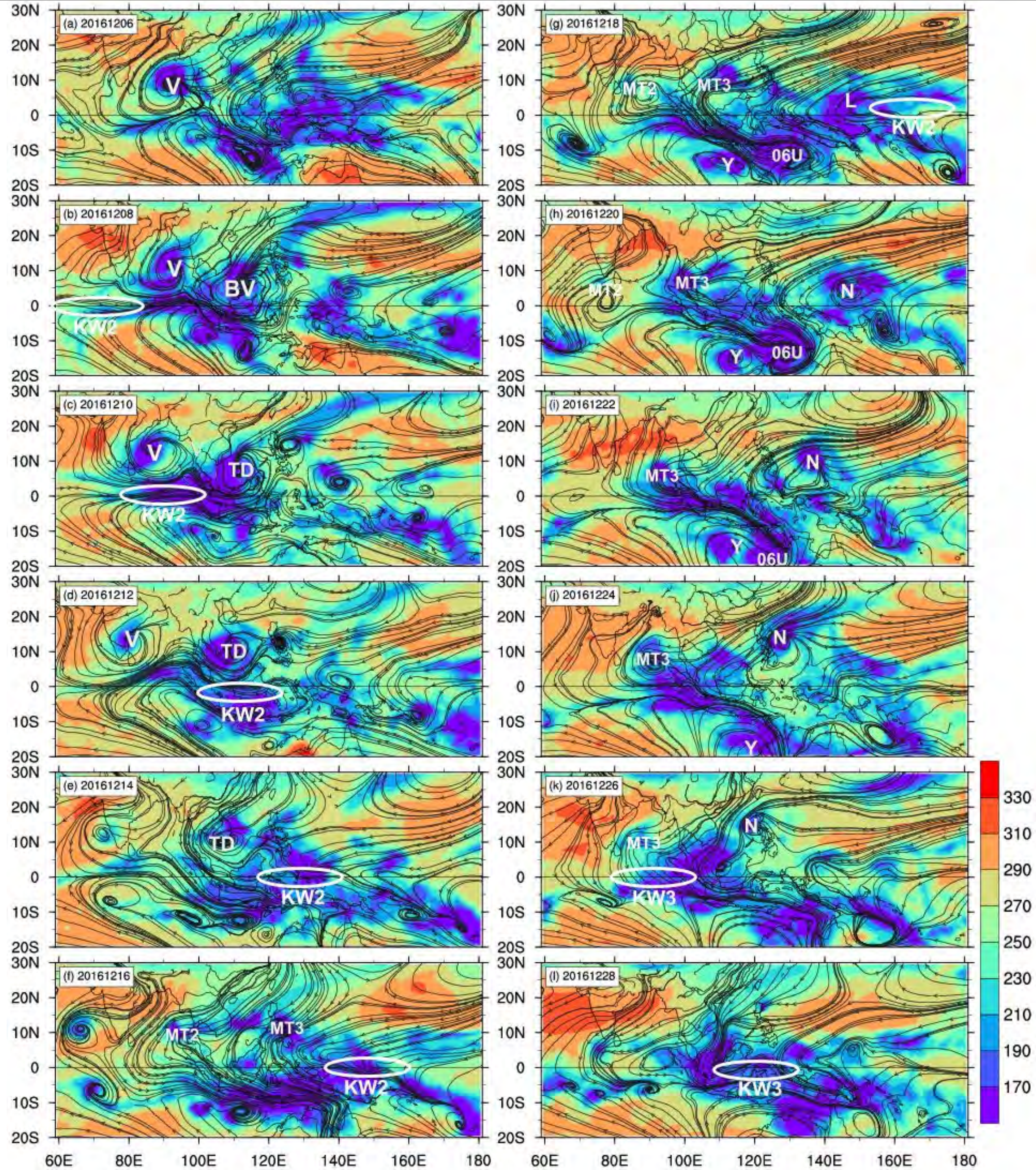

(a) Kelvin on 20161208
(b) ER on 20161208
(c) ER on 20161222
(d) MRG-TD on 20161208
(e) MRG-TD on 20161218
(f) MRG-TD on 20161222
20N
10N
0
10S
40E
60E
80E
100E
120E
140E
160E
180

Fig. 4

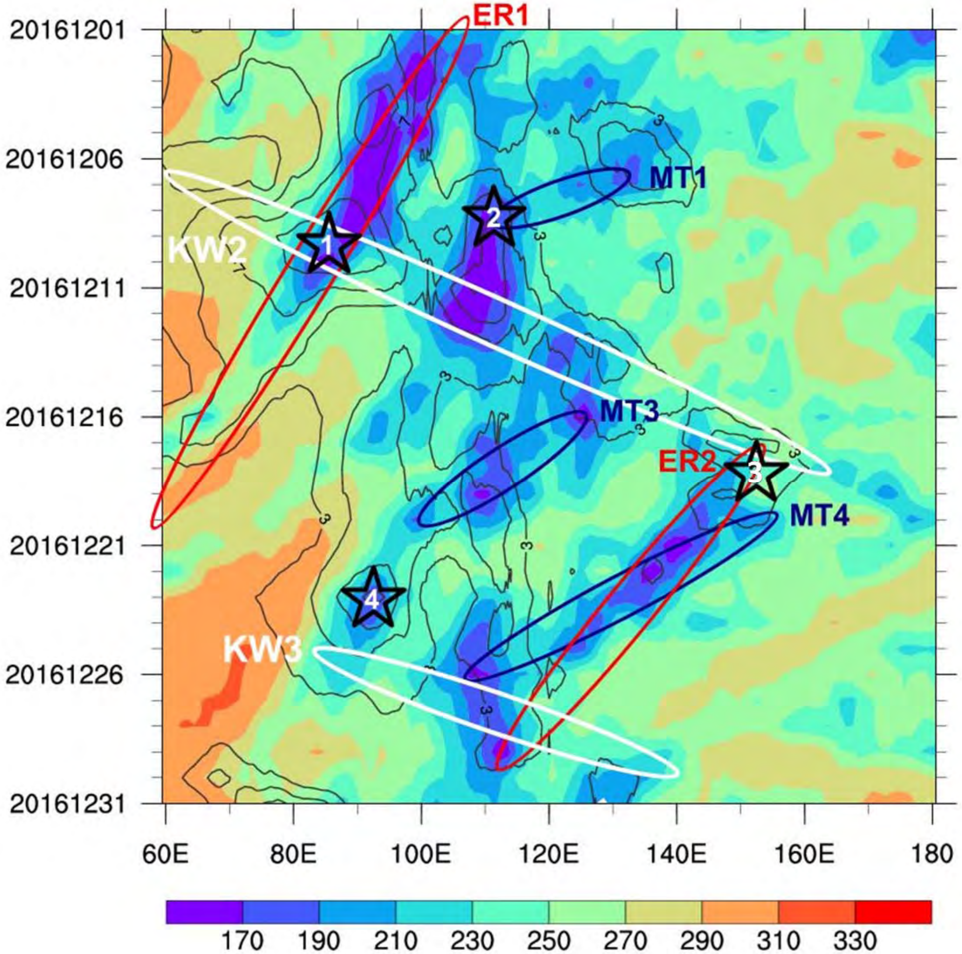


(a) 20161206
(b) 20161208
(c) 20161210
(d) 20161212
(e) 20161214
(f) 20161216
(g) 20161218
(h) 20161220
(i) 20161222
(j) 20161224
(k) 20161226
(l) 20161228
V
BV
TD
KW2
KW3
MT2
MT3
L
Y
06U
N
30N
20N
10N
0
10S
20S
60E
80E
100E
120E
140E
160E
180
330
310
290
270
250
230
210
190
170

Fig. 5

☆ indicates the location and time of scale interactions

Scale interactions



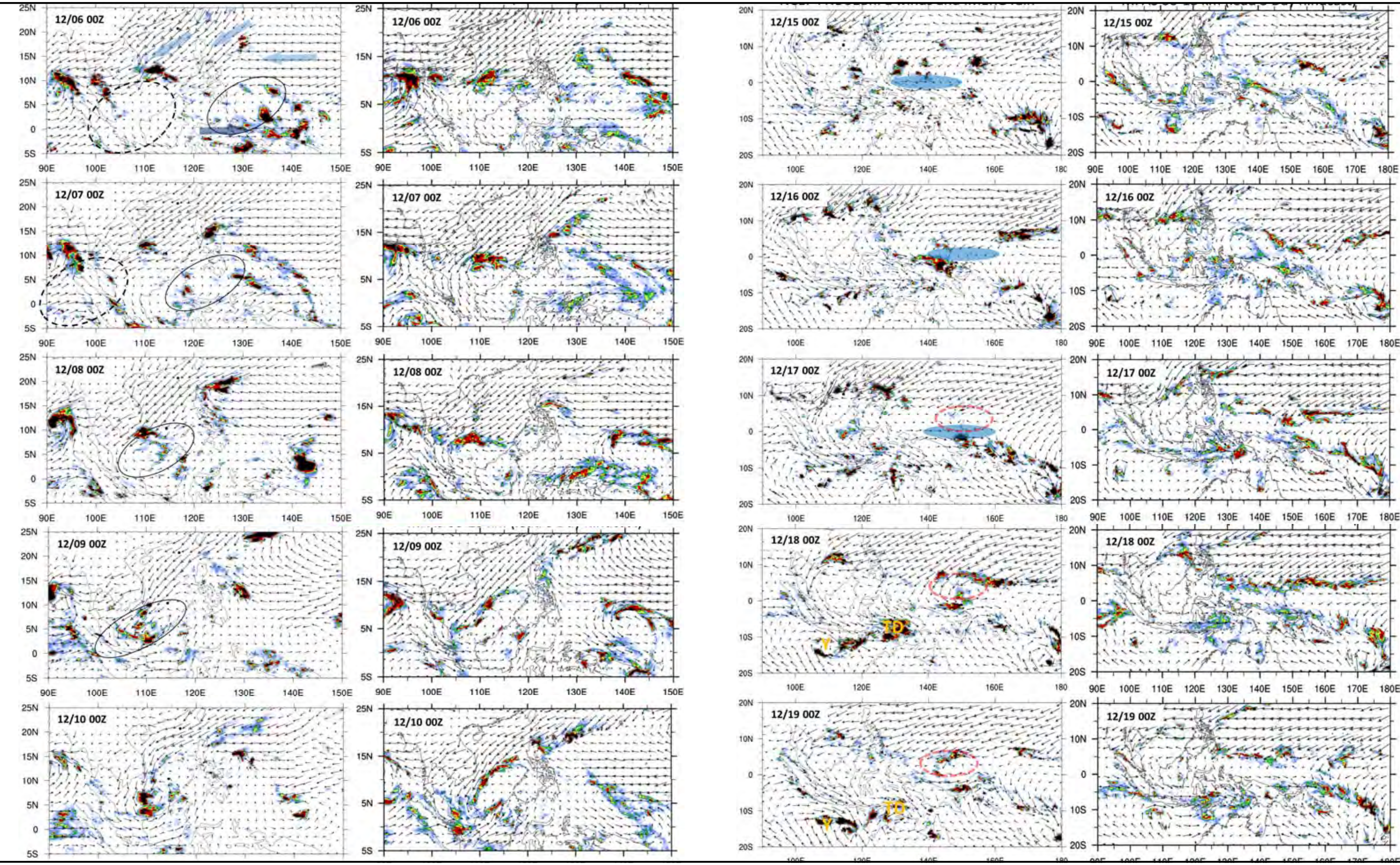
☆I1 TC Vardah in ER1 enhanced southwesterly winds and coastal convection over W Sumatra → KW2 enhanced

☆I2 MT1 over SCS → Borneo Vortex
+ KW2 equatorial westerly → TD

☆I3 KW2 + WP trade wind + ER2 → MT4/TC Nock-ten

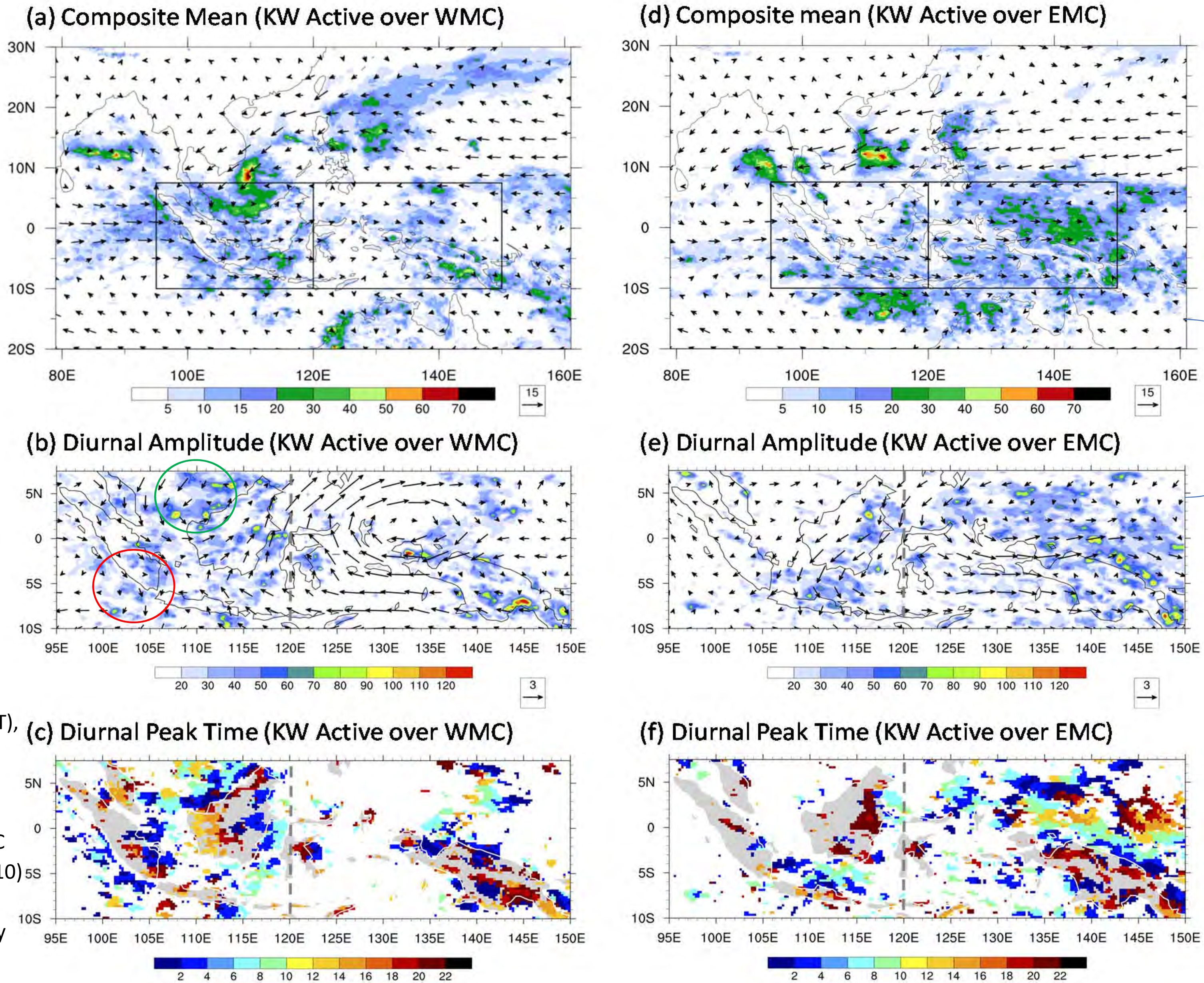
☆I4 MT3 → enhanced westerlies and convection over W Sumatra → terrain effect of Sumatra → KW3 enhanced

Fig. 7


12/06 00Z
12/06 00Z
12/07 00Z
12/07 00Z
12/08 00Z
12/08 00Z
12/09 00Z
12/09 00Z
12/10 00Z
12/10 00Z
12/15 00Z
12/15 00Z
12/16 00Z
12/16 00Z
12/17 00Z
12/17 00Z
12/18 00Z
12/18 00Z
TD
Y
12/19 00Z
12/19 00Z
TD
Y
25N
20N
15N
10N
5N
0
5S
10S
20S
90E
100E
110E
120E
130E
140E
150E
160E
170E
180E
180

Ichikawa & Yasunari (2006)

Yanase et al. (2016)

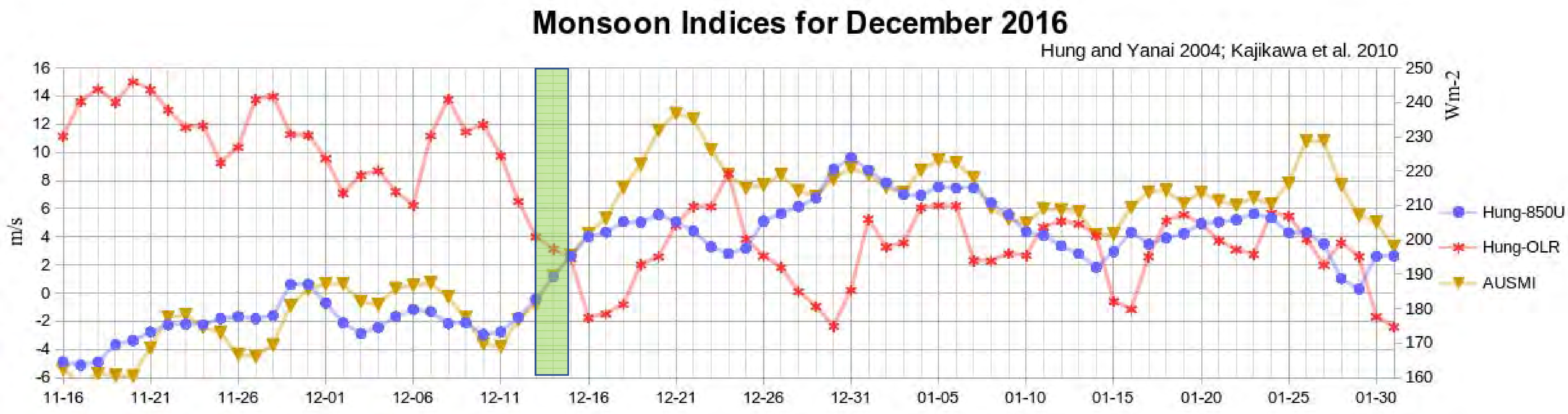


The distribution of the DC amplitude generally reflected the composite total value

Over land, the peak time in mountainous areas (14-20 LT), some downwind plain areas (00-04LT).
Over coastal ocean, a progressive phase shift in DC (00-04LT) near shore & (04-10) offshore, which features the ‘‘seaside coastal regime’’ by Kikuchi and Wang (2008).

Fig. 8

Australian summer monsoon indices:
(OLR, U850) (Hung and Yanai 2004); U850 (Kajikawa et al. 2010)



(2°S-11°S, 115°E-150°E; NAU) the first day when U>2 ms^{-1} (westerly) and lasts 10 days or more and the OLR<210 Wm^{-2} for several days within the 10 days.

U850 (5°S-15°S, 110°E-130°E). the first day after 1 November and (1) U850 during the 5 days following the onset day >0 ms^{-1}. (2) In the following four pentads, U850 must be positive in at least three pentads. (3) U850 >1 ms^{-1} for the accumulative four-pentad mean.U

Fig. 9

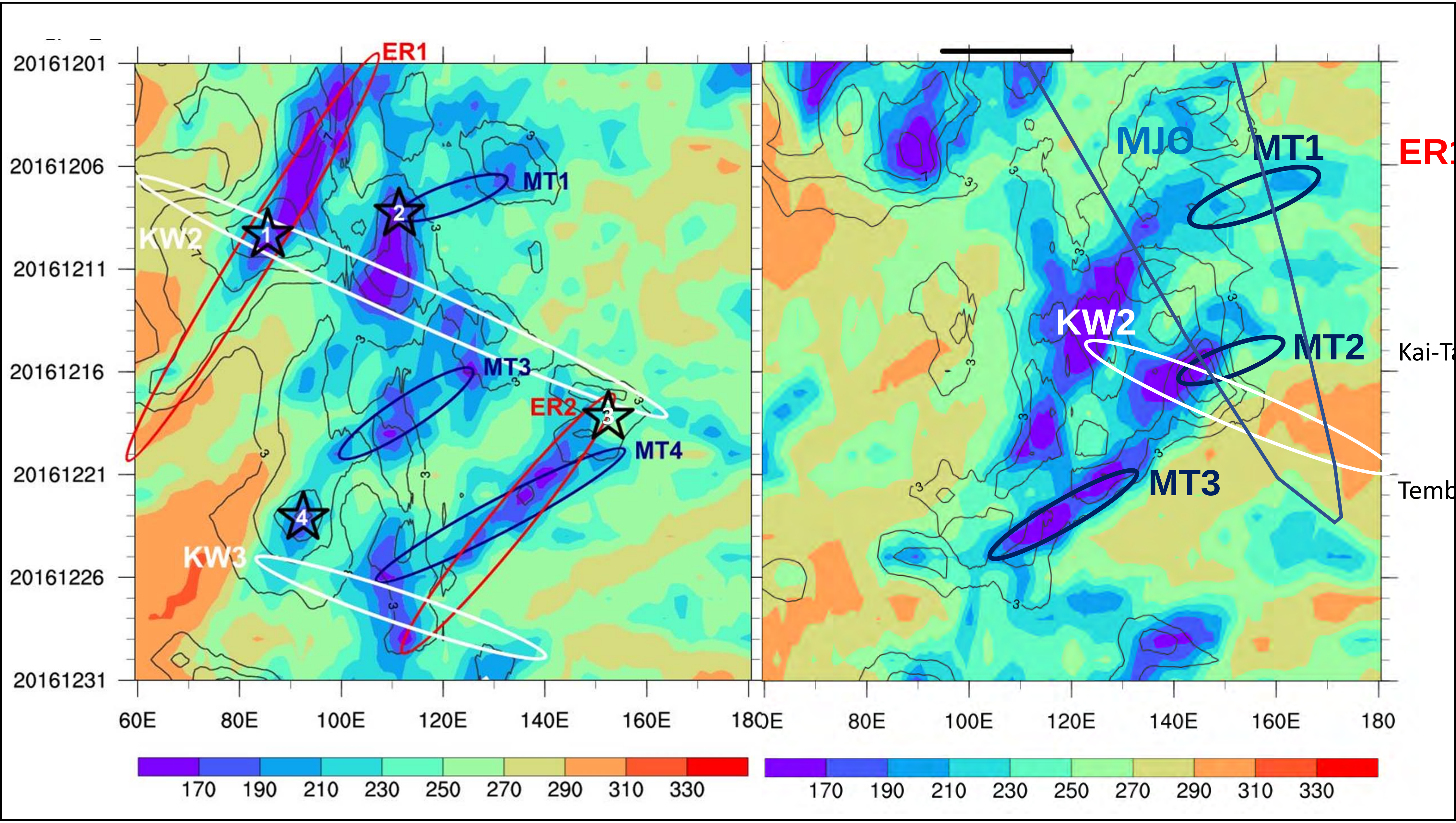
The Influences of Scale-Interactions Involving Convectively-Coupled Kelvin Waves on Rainfall Variability over SCS and MC in December 2016

1. Three KWs were observed while the MJO was inactive.
   Four interaction events between the KWs and the westward-propagating waves over the off-equatorial regions were examined: two events led to KW enhancements and the other two contributed to the formation of tropical depression/tropical cyclone.

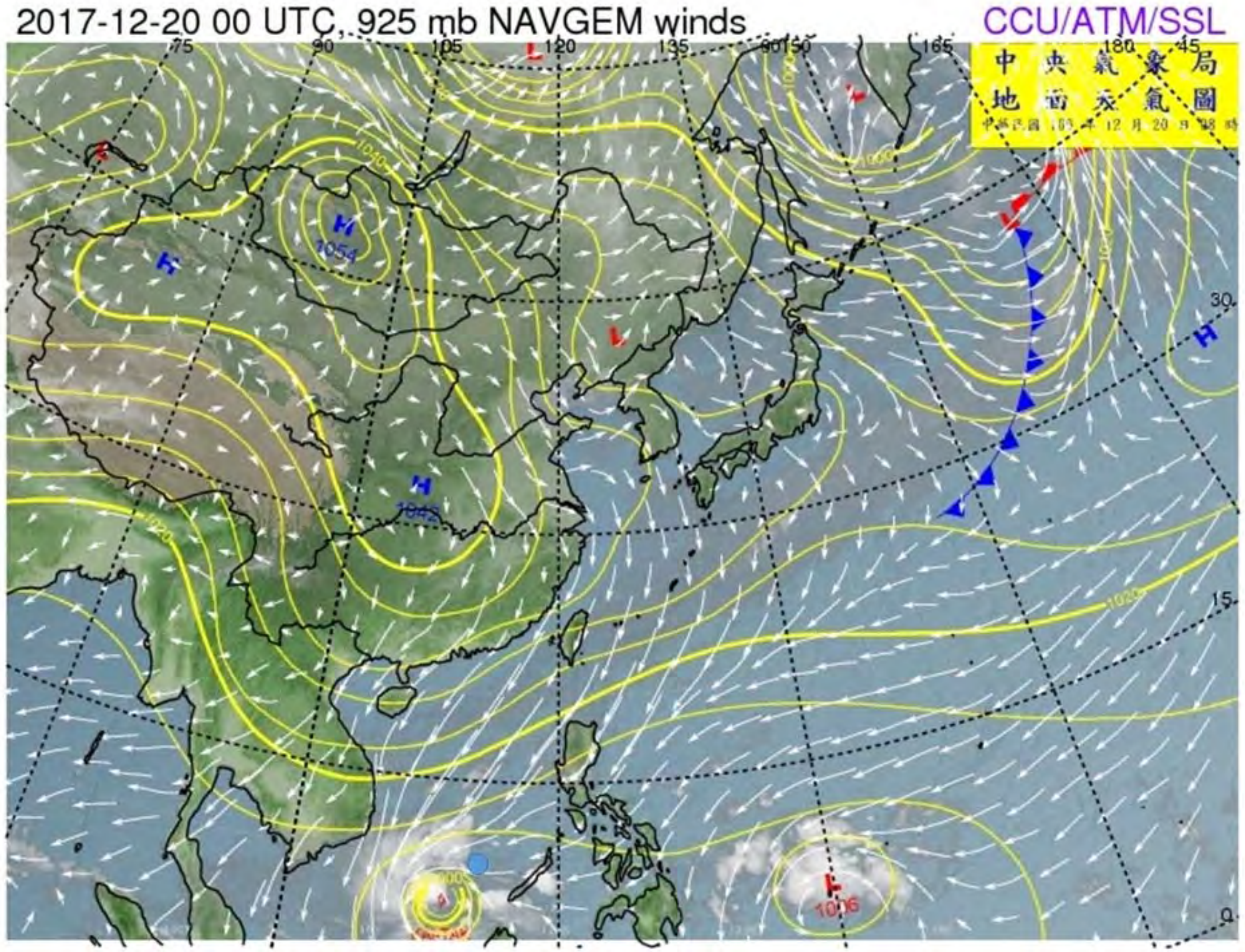
2. Over the KW convectiv region of MC, the diurnal cycle of precipitation was enhanced in major islands and neighboring oceans.
   Over land, the DC hotspots were modulated depending on the background winds & terrain effects.
   Over ocean, the "coastal regime" of diurnal cycle appeared at specific coastal areas.

3. The Australian Summer Monsoon onset occurred with the passage of a KW, which provided favorable conditions of low-level westerlies and initial convection over southern MC and the Arafura Sea. This effect may be helped by the warm sea-surface temperature anomalies associated with the La Niña condition of this month.

4. The current results indicate the importance of scale-interactions of the KWs with respective to synoptic disturbances, diurnal cycle, and Australian monsoon onset, at least when MJO is absent.



20161201
20161206
20161211
20161216
20161221
20161226
20161231
ER1
MT1
KW2
MT3
ER2
MT4
KW3
60E
80E
100E
120E
140E
160E
180
170
190
210
230
250
270
290
310
330
MJO
MT1
ER1
KW2
MT2
Kai-Ta
MT3
Temb



Kai-Tak 啟德颱風2017/12/15-24
Tembin 天秤颱風 2017/12/16-26
Bolaven 布拉萬颱風 2018/01/01-05

Kai–Tak Tembin and Bolaven tracks